Form Approved
OMB No. 0704-0188

1. AGENCY USE

May 1991

3. REPORT TYPE AND DATES COVERED

Professional Paper

4. TITLE AND SUBTITLE

IMPROVING MAINTENANCE PERFORMANCE: DESIGN STRATEGIES FOR TECHNICAL INFORMATION

5. FUNDING NUMBERS

PR: CE31
WU: DN308298
PE: 0603701N

6. AUTHOR(S)

R. J. Smillie

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Naval Ocean Systems Center
San Diego, CA 92152–5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Chief of Naval Operations
Department of the Navy
Washington, DC 20350

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

A-1

13. ABSTRACT *(Maximum 200 words)*

Several years ago there was a cartoon in the paper that parodied the U.S. Army's newest tank, the M–1. In the cartoon, the weight of the tank was listed as 73 tons with a proviso provided by the Pentagon stating that six of those tons were the owner's manual. The Washington Post's 1986 article on "Struggling to Understand Manual–ese" noted several examples of problems with poorly worded documentation that accompanies most of the consumer electronics products, e.g., VCRs. A local hospital recently issued a user's manual to assist the staff in interfacing with the hospital computer. For various reasons, the hospital had three different types of computer terminals that were networked to a central server. Rather than spend the money necessary to develop software for a single set of interface commands, three different sets of instructions, a unique set for each computer terminal, were compiled into a user's manual. The user was expected to learn and remember each set of appropriate interface commands. For example, to clear the screen at terminal 1 the user pressed the ALT-F2 keys; for terminal 2, the PAUSE key cleared the screen; and for terminal 3, the CLEAR key cleared the screen. The lack of any systematic approach to the design and development of technical information contributes to inefficient operation and ineffective maintenance performance. Data and techniques exist that demonstrate improved performance.

Published in Proceedings of the AIAA/NASA/FAA/HFS Conference on Challenges in Aviation Human Factors: The National Plan, Jan 1991.

14. SUBJECT TERMS

man-machine interface
decision support
decision making
decision aids
ASW
operability, operator functions

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAME AS REPORT

21a. NAME OF RESPONSIBLE INDIVIDUAL	21b. TELEPHONE *(include Area Code)*	21c. OFFICE SYMBOL
R. J. Smillie	(619) 553–8015	Code 443

IMPROVING MAINTENANCE PERFORMANCE: DESIGN STRATEGIES FOR TECHNICAL INFORMATION

Robert J. Smillie
Naval Ocean Systems Center
San Diego, California

INTRODUCTION

Several years ago there was a cartoon in the paper that parodied the U.S. Army's newest tank, the M-1. In the cartoon, the weight of the tank was listed as 73 tons with a proviso provided by the Pentagon stating that six of those tons were the owner's manual. The Washington Post's 1986 article on "Struggling to Understand Manual-ese" noted several examples of problems with poorly worded documentation that accompanies most of the consumer electronics products, e.g., VCRs. A local hospital recently issued a user's manual to assist the staff in interfacing with the hospital computer. For various reasons, the hospital had three different types of computer terminals that were networked to a central server. Rather than spend the money necessary to develop software for a single set of interface commands, three different sets of instructions, a unique set for each computer terminal, were compiled into a users manual. The user was expected to learn and remember each set of appropriate interface commands. For example, to clear the screen at terminal 1 the user pressed the ALT-F2 keys; for terminal 2, the PAUSE key cleared the screen; and for terminal 3, the CLEAR key cleared the screen. The lack of any systematic approach to the design and development of technical information contributes to inefficient operation and ineffective maintenance performance. Data and techniques exist that demonstrate improved performance.

DEVELOPMENT PROCESS

Effective design strategies for technical information emerged from research in job performance aids (JPAs). Basically, a JPA is a logical set of procedures, usually step-by-step instructions, supported by illustrations. The name itself, JPA, evolved from the instructional guidance developed to aid the performance of a specific job situation. Other names that are used are handbooks, job instructions, job aids, job guides, manuals, checklists, and procedures.

Until the 1950's, maintenance manuals had generally been written to describe only physical and functional attributes of the system. Specific procedures to operate and maintain equipment were generally demonstrated during training with the expectation that the technician/user would remember those procedures. If any particular procedure was forgotten, it was essentially a trial and error process that had to be followed to rediscover the necessary actions for that procedure. By applying the principles from behavioral science, however, it was found that the use of a step-by-step document used on-the-job reduced the learning requirement for procedures and facilitated accurate maintenance performance. The technician has only to read the procedure when that specific task is performed. These principles are:

1. Reliance on short-term and visual memories. Detailed procedural instructions are chunked into blocks of 5-9 steps or actions. These chunks are supported by explanatory illustrations.

2. Task oriented information. Only the information needed to complete a specific, well-defined task is provided.

3. Focus on the user. With an understanding of the skills and knowledge of intended users,

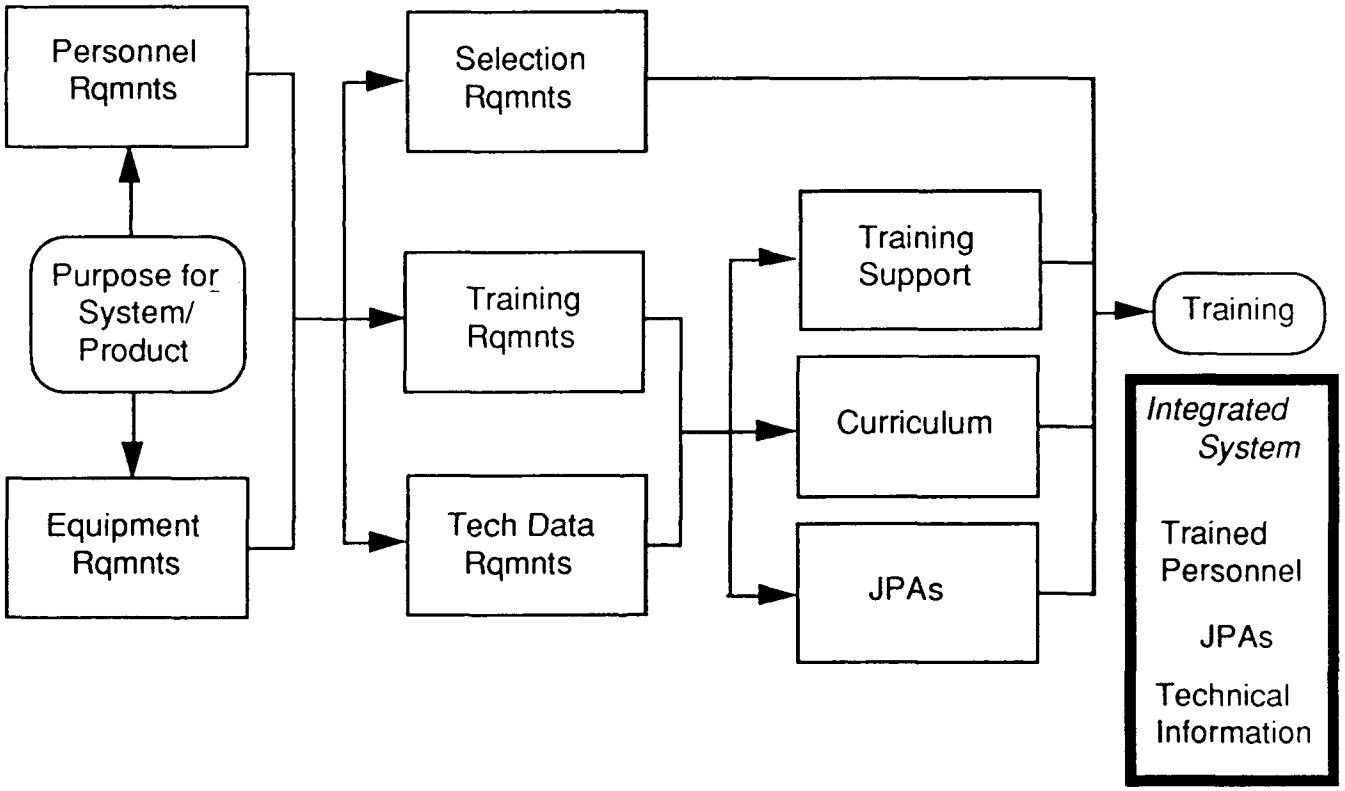
technical JPAs can be designed to support the information needs of the user population.

Thus, the technology to design and develop effective technical information evolved from JPA research in which the concept of task analysis could be used to define complete and concise job instructions, and identify the behavioral processes required for completing specific tasks. Technical information then, could be designed that matched the information content to the user population's needs. Research results since the early 1950's has supported that :

1. Use of JPA formats and techniques will reduce training because less time would have to be spent teaching procedures.

2. JPA formats and techniques will improve performance by providing individuals with a complete and accurate description of all actions that are required for a particular task.

For technical information to be effective, the development process has to be systematic. The technical information requirements have to be fully integrated with both personnel and equipment requirements. In the diagram below, a systems approach is shown in which the start point is the overall purpose (mission objective) for a product or system. Then, the various requirements are considered. Finally, the developer/analyst has to consider various trade-offs between training and technical information to determine how to meet the various requirements.



DESIGN STRATEGIES

In developing technical information, the design has to define a specific strategy. To do this, the designer has to focus on the purpose of the information, i.e., why is it being provided. In addition, the design strategy has to consider who the expected end user will be.

While paper has been the medium of convenience in the past, it lacks the flexibility of a modern computer-based electronic display. The electronic medium has to be exploited to improve both the organization of and access to technical information. Using an electronic presentation medium will afford the developer greater flexibility in tailoring formats to specific end users. For example, instead of presenting a dual level format, a single data base can be used to present a checklist for experienced users and a more detailed format for inexperienced users.

CONCLUSION

Well designed technical information in itself will not necessarily always lead to effective and efficient performance. In an integrated systems approach, all elements of a personnel system has to be considered. Application of the model shown below has demonstrated that it is possible to develop a personnel system concept where early on-the-job experience attracted individuals, deferred and distributed training supported reduced overall training requirements and saved personnel costs, and both low and high aptitude individuals were differentially accommodated and acquired the skills, knowledge, and experience necessary to progress in a career path.